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THE AFFECTIVE CHARACTERS OF THE MAJOR AND MINOR MODES IN MUSIC

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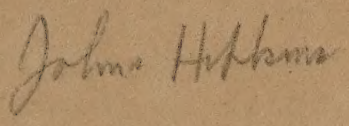
CHRISTIAN PAUL HEINLEIN

A DISSERTATION

SUBMITTED TO THE BOARD OF UNIVERSITY STUDIES OF THE JOHNS HOPKINS UNIVERSITY IN CONFORMITY WITH THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

JUNE, 1927



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THE AFFECTIVE CHARACTERS OF THE MAJOR AND MINOR MODES IN MUSIC

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I. HISTORICAL

For a long time the striking contrast in the psychological effect of the major and minor modes in music has been a standing puzzle for psychologists, physicists, and musicians philosophically inclined.

Pole, in his treatise on compound harmonies (17), refers to Hauptmann's curious metaphysical distinction (9) between the major and minor triads. He considers the major triad as a dynamic principle, determining or defining; the minor triad he treats as a passive principle, determined or defined. In the minor triad there is expressed a downward drawing weight, in the major triad an upward driving force. The minor triad he analogizes with the branches of the weeping willow, giving a *mournful* impression. This peculiar distinction between the reverse directive tendencies inherent in the two modes later led Oettingen (15) and Riemann (19) to formulate their theories of harmonic dualism.

Helmholtz (11) eulogizes Rameau (18) and d'Alembert (3) for having shifted much of the speculation concerning the nature of the major and minor modes from metaphysical to physical ground. Rameau and d'Alembert, unlike Tartini (28) who based his theory of consonance on the existence of combinational tones, founded the cause of consonance on the existence of upper partial tones. The fact that every resonant body audibly produces at the same time as the "generateur" its Twelfth and next higher Third as "harmoniques" led them to designate the major chord as the *most natural* of all chords. The minor chord, although prescribed

by nature, was not as natural and not as perfect as the major. The fact that the major triad was the more natural and the more perfect chordal structure made it, by a certain cosmic fundamentality and necessity, the more beautiful, the more pleasing, and hence the more desirable.

Helmholtz (11) refers at some length to the diverse psychological effects which are produced by the major and minor triads. The minor chords he considers especially adapted to express gloom, despair, sorrow, grief, mystery, longing, harshness, and obscurity, whereas the major chords are expressive of varying degrees of joy and excitement. The major triad sounds bright, clear, sweet, and hopeful, whereas the minor triad sounds veiled, sad, restless, and obscure. The cause for these opposite effects in feeling-tone aroused by the major and minor triads respectively is attributed to the nature and existence of combinational tones. The sad effect of the minor structures is held to be a result of a peculiar nervous disturbance caused by the slight dissonance introduced through the altered tone.

Gurney (8) is quick to recognize the melancholy effect produced by the minor triad. He holds that the effect produced by either type of chord is relative to the character of the scale upon which the combinations are constructed. The melodic effect accounts for the chord effect on the basis that the notion of a potential passing from one note to another lies at the root of the perception of distance as a relation which they present, and some faint perception of distance or interval, he holds, is practically always present in the impression of a chord.

Standing in opposition to the figured-bass harmonic system, we have the dualistic harmonic system of Riemann (20) and Oettingen (15). These investigators hold that the tonic is the central point of a symmetrical tonal distribution, that the major and minor triads stand in opposition to each other, and that the minor triad is the mirrored reciprocal of the major triad. If the subdominant is explained as the under-dominant, and the two triads as mirrored counterparts, an explanation of the diverse feelings which these two structures engender is not considered difficult.

Stumpf (26) in reviewing the theory advanced by both Oet-

tingen and Riemann, argues that the concept of harmonic symmetry and reciprocity is a product of reason, and finds no direct analogue in immediate perception and feeling, at least not for the average individual who, nevertheless, reacts differently to the two modes in question. He believes that a more adequate explanation for the major-minor enigma is to be found in his principles of tonal fusion.

Pear (16) in studying the fusion aspect of major and minor intervals, agrees with Külpe (12) that the clang-relationship explanation of Wundt (32) does not represent a satisfactory theoretical basis for the obvious differences between the major and minor modes. The harmonic differences can be more adequately explained on the basis of fusion: and the assumption is held that the degree of fusion of a chord varies with the position of its constituent degrees of fusion within the tonal scale, decreasing when the worse degrees are the lower, and increasing when they are higher.

Waiblinger (30) disputes the validity of Pear's conclusions, and holds that the mere interchange or reversal of the constituent intervals from lower to higher position and vice versa, is not sufficient to explain the differences which tend to exist between the two chords.

Britan (2) maintains that the approach to the major-minor mystery through the channels of dissonance and fusion-perception does not lead to any adequate solution. His explanation is based upon the function of rule-contrast. The Greek Lydian mode, which by custom, repetition, and final adoption has become the modern major diatonic scale and the basis of music in the western world, represents the standard of mental reference and the form in which creative musical thought is involuntarily conceived. In brief, "conformity to this standard is the secret to the emotional value of the major mode, un-conformity the secret of the minor mode." Thus, in the minor scale, when we feel the unrest, sadness, and yearning it produces, we are yearning in reality for the natural order of the major mode. Britan's explanation in regard to clang relationship is essentially the same as that of Gurney.

Gilman (7), who represents a pioneer figure in the study of

musical expression from the experimental point of view, holds that some real expressiveness undoubtedly exists in musical forms. He believes that there is good reason to think that general forms of prevalent agreement tend to emerge from the impressions of different listeners to the same piece. He points out that so intimate is the connection between the lesser Third and feelings of sadness that the adjective "minor" has been taken up in our common speech as a synonym of "sorrowful."

Weld (31), in studying both the physiological and introspectional aspects of musical compositions, partly agrees with Gilman that a composition itself may arouse a mood of its own making. The results of his experiment emphasize, however, the diversified reactions of subjects attending to the same composition. The various types of reactions given are held due to the dominance of mood, composition and content of emotion, profusion of imagery, and intensity of motor reaction in relation to the emotional setting provided by the musical rendition. The nature and complexity of the organic condition at the instant of rendition are held as inseparable factors in the determination of the subsequent reactions.

Downey's results (5) from the presentation of whole compositions follow those of Weld. Downey finds that a great difference exists both in the capacity of individuals to receive definite impressions and of composers to convey them. The emotional content received by any listener is held to be furnished entirely by the mood, associations, or temperament of the individual. This same view is expressed by Beaunis, Lee, and Feldkeller. Beaunis (1) in discussing the emotional element in music and its relation to rhythm, duration, intensity, and pitch, and the general sympathetic vibration of the body, points out that emotion is conditioned by the mentality of the listener, by the auditory sensations and by the muscular and tactile sensations existing at the moment of rendition. Lee (13) emphasizes the rôle which momentary moods play in the judgment of the listener, and points out that some individuals respond specifically through the focus of attention, while others remain more passive and allow the mind to wander. Feldkeller (6) likewise emphasizes the rôle

which the intellectual processes play in the enjoyment of the best music, and protests against the over-emphasis accorded to the existence of *einfühlung* in aesthetic judgment.

Relative to the type of investigation in which tonal elements are presented, Valentine (29) conducted an experiment to determine the aesthetic effect of different intervals. Counter to expectations, he found that major intervals are described as sad or plaintive twice as often as minor. In a trichord experiment in which *c'* was always used as tonic, the major triad was termed *sad* as frequently as the minor.

Lowery (14) devised sequences of major and minor chords grouped in pairs for finality judgment in modulation. Designation of the more complete cadences was priorily assumed and arranged. The subjects' results do not coincide with the expected judgments of the experimenter. Lowery found that the chord built on the fifth degree of the scale as root has a certain satisfying effect due to its being the tonic chord of the key having, as key signature, the key signature of the test with one sharp added. The investigation does not throw much light on the hedonic tone of the two modes.

Danzfusz (4) conducted an experiment for the purpose of ascertaining the existence of the joyful-melancholy dimension of feeling supposedly intrinsic to the major and minor modes. His results stand in contradistinction to those obtained by Valentine. The characteristic response for the minor triad is one of *melancholy* and *sadness*, whereas the major chord in most instances was reacted to as *clear*, *strong*, *joyful*, and *bright*. Danzfusz agrees with Helmholtz, Stumpf, and Krüger that the difference and combination tones and their respective frequencies play a dominant rôle in the impressions afforded by the major and minor structures, and that the effect produced is largely one of consonance modification.

In briefly summarizing, it can be seen that, with the exception of Valentine, investigators have been prone to ascribe two very definite categories of feeling as being intrinsically related to the two modes. Helmholtz, Gurney, and Britan have emphasized in considerable detail the inseparable relation between the minor

triad and feelings of grief and melancholy. The minor triad is attributed with the power to initiate spontaneously a nervous reaction which terminates in various types of organic depression.

Unfortunately, few experimental investigations have been conducted for the purpose of proving or disproving these theoretical considerations. Two chief types of experimentation have been attempted: the one type makes use of whole compositions or complex musical phrases as stimuli, the other type provides intervals and chords as stimuli for aesthetic judgment. Of the latter type, much confusion has existed in the results obtained. Valentine has attempted to show that no specific feeling-tone is intrinsic to chords of either mode, whereas Danzfusz, at a later date, in summarizing his results which stand in contradistinction to those of Valentine, returns in support of the contentions forwarded by Helmholtz.

Whole composition effects have proved quite fruitless in a study of the effects produced by either mode because of the large number of complexities involved in an extended musical configuration which defies any simple analysis. The approach to the major-minor problem through the medium of simple tonal stimuli unrelated to other complex patterns which function in reaction, is by far the more adequate and scientific method. Experimenters to date have not sufficiently recognized the importance of controlled conditions. The results of Gurney, Valentine, Danzfusz and others are doubtful because no attempt was made to provide for accurate, scientific control of the intensity factor in striking the chords. The experiment here undertaken avoids the dangers involved in intensity or duration fluctuations through the introduction of mechanical production providing for constant conditions in both intensity and duration.

II. EXPERIMENTAL

General problem. The following experimental investigation has been outlined for the purpose of ascertaining the nature and constancy of verbal affective responses (especially in regard to the melancholy-joyful dimension of feeling so emphasized by various

investigators and musicians) on the part of both musically trained and untrained subjects to isolated chordal combinations, including all keys in both major and minor modes, with the intensity factor varied under mechanically controlled conditions. A secondary problem, preceding and related to the investigation proper, was designed for the purpose of ascertaining ease in discrimination between two chords with altered Third in soprano position and between two chords with altered Third in alto position, or the second tone above the root. Ability in this type of discrimination was correlated with the Seashore pitch discrimination test (21:22) employing phonographic recording. Ability to discriminate between major and minor chords in the tonic position with the Third in the soprano and with the root repeated in the soprano, was also introduced as a preliminary experiment.

Apparatus. A Columbia console model electric phonograph was used to play the Seashore pitch discrimination record. The chordal schemes were presented on a Weber upright Duo-Art[1] reproducing piano.

Subjects. Thirty subjects were employed in all. Ten subjects were employed in the preliminary experiment involving chordal discrimination. Each subject was personally interviewed before he was elected to serve as reactor, in order to ascertain his interest in the work and also his approximate musical background. Before any experimentation began, each subject was required to fill out a questionnaire relating to his general education, his musical environment during youth, his musical education and training, his musical activity and interests, and finally the nature and extent of his musical memory and imagination. The questionnaire form used was that designed by Stanton (24).

The subjects were classified into *trained* and *untrained.* The phrase "trained subject" as used for classificatory purposes in this investigation, has reference to an individual who, within some period of his life, has taken fifty or more one-half hour les-

[1] The author wishes to express his appreciation to the Aeolian Company of New York City for their courtesy in extending the loan of a Duo-Art piano and for their kind coöperation in the manufacture of special rolls.

sons on some musical instrument or in singing, and who shows in the results of an individual test, corresponding ability at performance and knowledge of rudiments and of musical facts proportionate to the nature, scope, and period of his training. An "untrained subject" is one who has had no formal training as defined above, or, who having had some "training," gives no evidence whatever of any retention or of any acquisition in the broadest sense of the term, and who gives no evidence of possessing any knowledge of elementary musical facts.

Experiment I

This experiment represents a group of preliminary tests designed for the purpose of ascertaining degree of difficulty in discrimination between major and minor chords when presented in (*a*) the tonic open position with the root repeated in the soprano, and (*b*) in the tonic open position with root doubled in the bass and the fundamental triad Third introduced in the soprano.

Four master test forms were constructed, each form consisting of fifty pairs of chords. In form 1, all chords are represented in tonic open position with the root repeated in the soprano. This position is referred to throughout the text as either *tonic* or *root* position. In form 2, all chords are represented in the tonic open position with the Third of the fundamental triad inverted to soprano position. This chordal position is referred to throughout the text as the *inverted* position. (This use of the word "inverted" must not be confused with the customary reference to the tonic triad inversion, in which the Third of the fundamental becomes the root of the chord of the Sixth.)

In each of these forms, two pair-types are included. The first type represents a pair in which the chords are identical in their tonal structure: the second type represents a pair in which the chords differ from each other through the alteration of the triad Third by a semi-tone ascent or descent. Such alteration transforms a major chord into a minor chord, or a minor chord into a major chord, either chord being founded upon the same fundamental as root.

In the case of type 2, the modes were presented in reverse sequence for any given key. For example, if a pair was represented

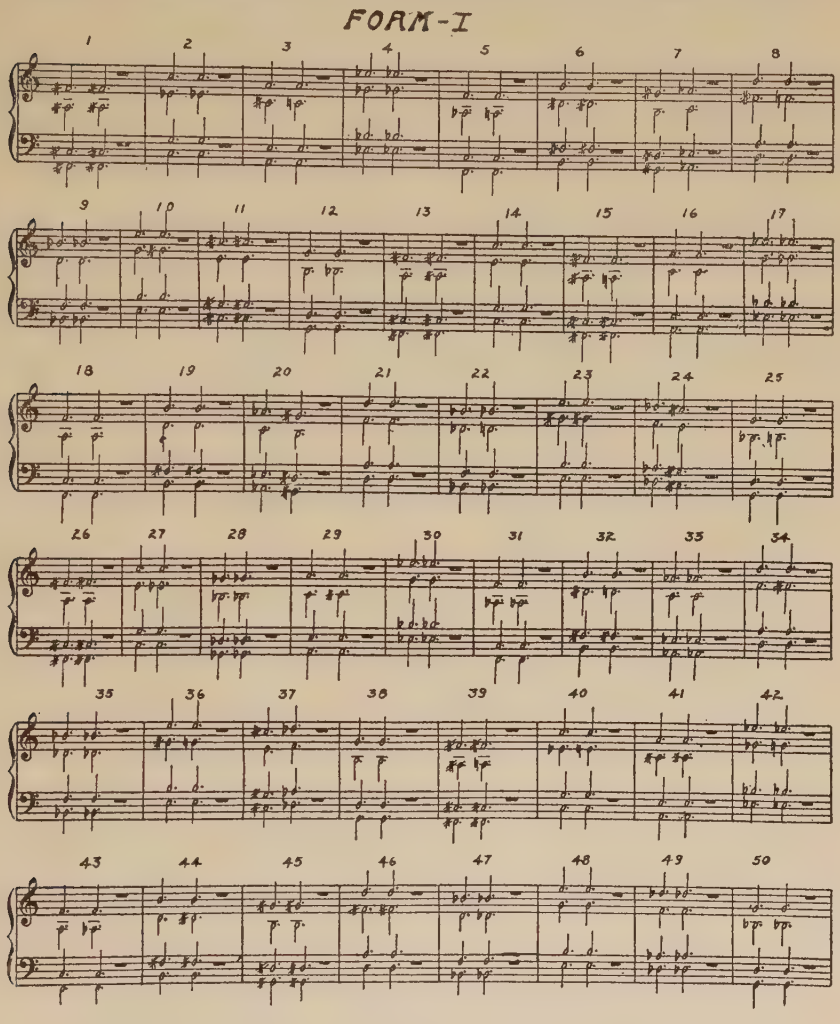

Fig. 1

by the chords of E-minor and E-major, somewhere in the test the sequence of E-major and E-minor was employed. Twenty-five pairs of each type, involving all keys played in middle range, were

included in each test form. In forms 1-A and 2-A, the two chordal positions employed in forms 1 and 2 were interspersed: that is,

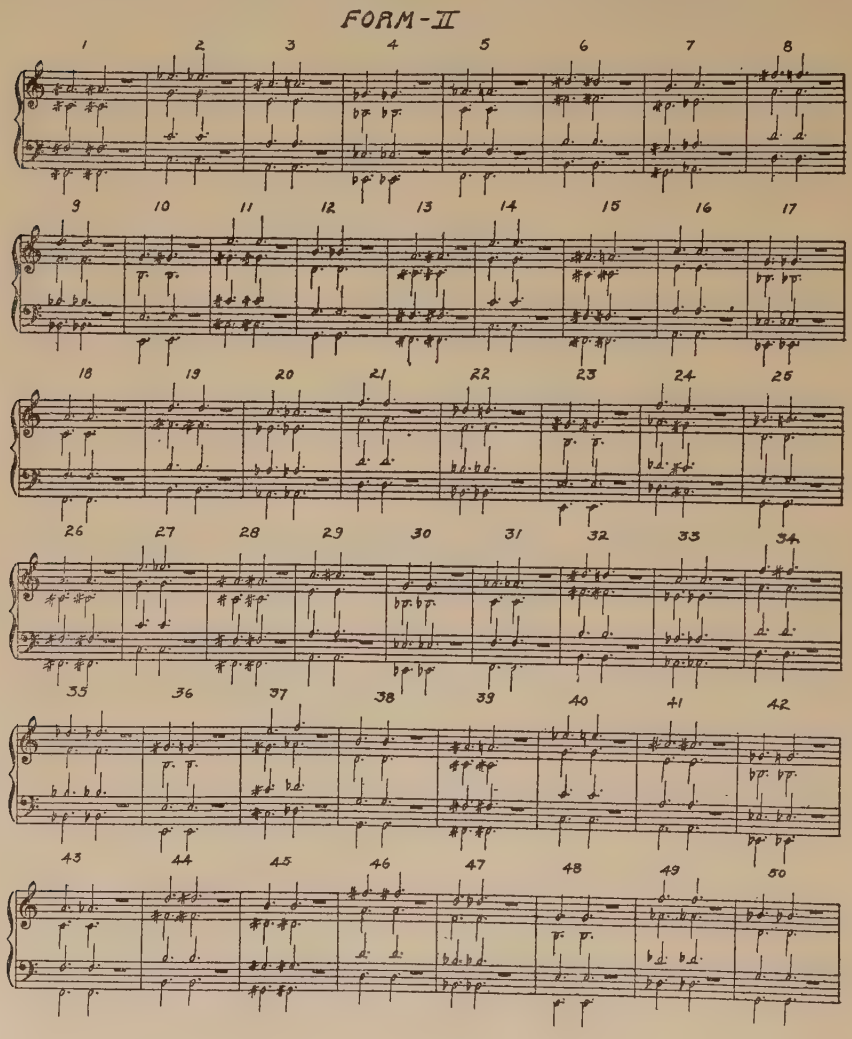

FIG. 2

each form consisted of twenty-five pairs in root position and twenty-five pairs in the inverted position. The sequence of pairs within any given test was arranged in such a manner as to avoid the

customary and familiar harmonic relations existing in the table of Fifths (10). Figures 1 and 2, which are notated representations of forms 1 and 2 respectively, indicate at a glance the harmonic disparateness which prevails between successive pairs. Such avoidance of harmonic relationship, and the introduction of melodic skips in the root uncommon with diatonic usage, provide an adequate means for eliminating to a considerable degree the possibility of sequential memory as well as lessening the chances for recognition and delimiting the function of melodic and harmonic associations which play such a significant rôle in the auditory experience of musically trained subjects.

The chords were fingered by the experimenter and played mezzo-forte throughout each test. Great care was exercised to keep the intensity factor practically constant. Each chord was sustained three seconds. A time interval of one second separated the chords of a pair, while a time interval of five seconds separated the pairs from each other. No pedal sustention was employed at any time during the test; sustention was maintained throughout by key control.

The time factor was controlled by a light rhythm. A small 1.5 volt mazda lamp was connected in series with a make-and-break mercury-cup-contact metronome which was enclosed in a cardboard box contained in a wooden case situated in an adjoining room. The metronome could not be heard in the music room where the tests were being conducted. A screen, which did not serve as an obstacle to the sound waves, was placed between the performer and the subjects: this prevented the subjects from being disturbed by the light flicker. The metronome was adjusted so as to produce a flash in the lamp every second. The lamp was placed on the piano at a convenient angle before the performer. The experimenter counted mentally the light-flashes in groups of four. The first chord of a pair was struck coincident with the first flash of a group of four flashes. Simultaneous with the fourth flash, the keys of the piano were released, and the next chord struck coincident with the fifth flash which by rhythmic count in four-four time became the dominant beat of another group of four flashes. At the occurrence of the eighth

flash, or the fourth flash of the second group of flashes, the piano keys were again released and struck until another rhythmic group of four flashes had transpired. This method was used throughout the test.

The subjects sat in comfortable chairs facing the piano. They attended the tests both individually and in small groups of two or three members. For each subject, three separate one-hour sessions on three different days constituted a weekly schedule. Whenever possible, the subjects were asked to attend on successive days at the same hour.

On the first scheduled test period, tests 1 and 2, which correspond to forms 1 and 2, were given. An interval of approximately fifteen minutes between each test was allowed the subjects as a rest period. On the next day, tests 1 and 2 were repeated as test *B* and *A* respectively for the purpose of obtaining test reliability results. Instead of presenting the tonic position first in conformity with the initial test procedure, the inverted position was presented as preceding the tonic. On following test periods, the chords were presented in different pair orders; however, in every test the aforementioned harmonic disparateness between pairs was maintained. A pair of tests—each test of a pair consisting of fifty pairs of chords representing one or both of the two adopted chordal positions—was given each test period. Thus, similar to the previous procedure, on the third day tests *C* and *D* were given, on the fourth day tests *E* and *F*, on the fifth day tests *G* and *H*, and so on until twenty tests had been given. Tests *K* and *L*, *M* and *N*, *O* and *P*, and *Q* and *R* represent forms in which both chordal positions are included for a single test.

The following directions were presented to each subject:

> You will hear two combinations of several tones each. Each combination will contain the same number of tones, namely four. These tonal combinations, with the tones of each combination played simultaneously, are usually referred to as musical chords.
>
> Hence, using the more customary musical terminology, you will hear a series of pairs of musical chords, containing the same number of tones, played consecutively. In some of the pairs which you will hear, the two chords played are identical in their tonal structure. That is to say,

either chord of the pair will be made up of exactly the same tones. In some other pairs which you will hear, the chords of each pair will be different in their tonal structure: the difference existing between any two chords of a pair will be the change of a single tone in the second chord.

If the two chords of a pair are identical in their tonal structure, record "S" in the proper space provided on your paper. If the two chords are different in their tonal structure, record "D." You are not expected to attend to any differences in intensity or duration which may happen to exist at any time: these factors do not, and should not, enter into your judgment. Each pair will be played but once. Do not omit any judgments: if in doubt, guess. After a judgment has been recorded, do not change it.

Table 1 gives each subject's achievement scores based on per cent of correct responses. The tests of periods 7 to 10 inclusive, which coincide with tests *K-L*, *M-N*, *O-P*, and *Q-R*, are computed and scored on a tonic-inversion basis of correct responses for each chordal position. Since each pair of tests contains the total number of pairs for each chordal position, such computation is made possible.

The results, although evidencing marked individual differences in response, emphasize one fact; namely, that both trained and untrained subjects find it easier to discriminate between two chords in the inverted position than in the tonic position. In the records of subjects 4 and 7, one sharp deviation in the score of the inverted position is noticeable. Examination of the test papers and of the introspective reports obtained from these subjects confirmed these deviations as the result of momentary fluctuations of attention following the function of fatigue initiated prior to the test period. In consideration of some of the subjects' manifest disquietude toward the close of the entire experiment because of the monotony provided by repeated presentation of similar stimulus material over a period of several weeks, many of the remaining deviations may be assumed the result of either momentary or prolonged fluctuations in attention.

For subjects 4, 5, and 8, representing the best musically trained individuals in this group of ten, the two chordal positions proved

about equal in difficulty for discrimination. For subjects 3, 6, and 7, all musically trained, but not to the extent of subjects 4, 5,

TABLE 1

Giving each subject's achievement scores for the twenty tests in chordal discrimination

A subject's number followed by an asterisk indicates a musically trained individual. The numbers of the outer left column arranged serially from 1 to 10 indicate the successive test periods. Columns headed by the letter "R" give test scores in root position: columns headed by the letter "I" give test scores in inverted position. At the bottom of each column is indicated the average score and average deviation for the ten tests in either chordal position.

TEST PERIOD	S-1		S-2		S-3*		S-4*		S-5*	
	R	I	R	I	R	I	R	I	R	I
1	80	94	78	96	74	96	100	100	92	100
2	82	90	96	96	76	98	100	100	96	98
3	96	100	92	100	86	94	100	100	100	100
4	92	96	90	100	92	100	100	84	98	100
5	84	94	88	100	88	96	100	100	100	100
6	96	98	94	100			100	100	100	100
7	98	98	98	100			100	100	100	100
8	100	100	94	96			100	100	100	100
9	98	100	96	100			100	100	100	100
10	98	100	98	100			100	100	100	100
Average...	92.4	97.0	92.4	98.8	83.2	96.8	100	98.4	98.6	99.8
A.D.....	6.32	2.80	4.32	1.68	6.56	1.76	0	1.60	1.96	0.36
PERIOD	S-6*		S-7*		S-8*		S-9		S-10	
1	84	98	86	98	100	100	76	88	70	100
2	92	100	88	100	98	98	90	100	68	96
3	94	96	82	98	100	100	92	100	68	94
4	92	96	86	100	100	100	92	98	92	100
5	92	100	88	96	98	100	86	100	90	100
6	90	100	94	82	100	100	92	98	92	100
7	92	98	96	100	100	100	82	100	96	100
8	92	98	88	100	98	100	86	100	96	98
9	92	100	82	100	100	100	84	100	98	100
10	94	100	90	94	100	100	80	100	94	100
Average...	91.4	98.6	88.0	96.8	99.4	99.8	86.0	98.4	86.4	98.8
A.D.....	1.76	1.40	3.2	3.68	0.84	0.36	4.4	2.24	10.64	1.68

and 8, the inverted position was found easier for discrimination. (Subject 3 did not take the entire series of tests.) Subjects 1, 2,

9, and 10 all found the inverted position easier for discrimination. Subjects 1, 2, 3, 5, 6, and 10 show a learning rise in the tonic position, whereas subjects 7 and 9 evidence a decline, a condition which cannot be readily accounted for except on the aforementioned assumption of affective decline leading to definite attention fluctuations. From an analysis of the error frequency to specific pairs on successive days, the fact is revealed that subjects, both trained and untrained, err on different pairs in different tests given on different days. However, some subjects seem to find certain pairs more difficult than other pairs. For the group as a whole, most errors were made on the following pairs (each pair totalling 15 errors or above): 5, 12, 13, 15, 17, 20, 36, 39, 42, 43. Six of these pairs are in the low register, having F, F-sharp, and G as soprano in the octave of middle C. Three pairs are in upper register, having E-flat and E as soprano in the octave above middle C. Thus it is found that the greatest number of errors occurs in the low and high pitch registers. This leads to the conclusion that chordal modification is more easily discriminated in middle register. Moreover, the sums of the several frequencies of the various tests conclusively indicate that error in discrimination of pairs consisting of diverse constituents is more probable than error in identification of pairs consisting of the same constituents.

Experiment II

Following the experiment in chordal discrimination as preliminary to the main investigation, 20 more subjects were recruited from the college student body and grouped together with the first ten subjects. These 30 subjects were then given the Seashore pitch discrimination test. The Seashore pitch discrimination phonograph record was used. The phonograph was set to run at 78 R.P.M. The subjects were supplied with the usual test blanks and the customary instructions read to them (23).

The results obtained from this test are tabulated in table 2. Column B gives the individual averages, while column C gives the rank of each subject. The group as a whole averaged quite low. Only three trained subjects have a rank above 70. Of the un-

TABLE 2

Individual scores computed on a per cent correct basis for (A) chordal discrimination (average score for first two tests, test 1 including fifty pairs in root position, and test 2 fifty pairs with the Third inverted to soprano position), (B) pitch discrimination (Seashore); (C) individual ranks in pitch discrimination; and (D) major and minor modal differentiation

(An asterisk indicates a musically trained subject)

SUBJECT	TESTS					
	I	II	(A)	(B)	(C)	(D)
1	80	94	87	51	1	80
2	78	96	87	70	15	54
3*	74	96	85	83	63	80
4*	100	100	100	82	56	100
5*	92	100	96	84	70	72
6*	84	98	91	74	23	66
7*	86	98	92	82	56	78
8*	100	100	100	84	70	100
9	76	88	82	74	23	60
10	70	100	85	81	50	54
11*	98	100	99	85	76	78
12*	92	98	95	81	50	86
13	86	92	89	75	26	
14*	94	100	97	53	1	80
15	74	72	73	71	17	38
16	100	100	100	86	81	100
17*	92	96	94	82	56	100
18	70	82	76	79	40	56
19	78	92	85	68	12	88
20	84	86	85	61	5	46
21*	100	100	100	54	1	100
22*	82	82	82	59	4	70
23	82	86	84	90	96	
24	94	94	94	78	36	
25	82	82	82	56	3	74
26*	98	98	98	54	1	84
27*	98	96	97	93	99	90
28	88	92	90	69	13	50
29*	100	100	100	85	76	80
30	98	100	99	82	56	96

trained subjects, only two have a rank above 70. The average score for the group is 74.2, with an average deviation of 10.4. The median is 79.5, the mode is 82 (4 cases).

The results of this test indicate that pitch discrimination involving minute pitch differences is not necessarily one of the so-called fundamental requisites or factors in the make-up of the musically trained who have become successful performers (21). A mere glance at the ranks scored by most of the trained subjects will convince one of this fact.

Experiment III

The same 30 subjects who took the Seashore pitch discrimination test were given a test in major-minor discrimination. This test was given the same period after a rest-period of fifteen minutes. The method of procedure was similar to that employed in *Experiment I*. Fifty chords were presented for discrimination, and were played mezzo-forte on the piano by the experimenter. Twenty-five chords were in the major mode, and twenty-five chords in the minor mode. Both chordal positions, tonic and inversion, in all keys, were included. The entire test is notated in form III, figure 3. Light rhythm was again utilized for duration control. Each chord was sustained four seconds, with a time interval of four seconds between successive chords. The following directions were presented to each subject:

> You will hear a series of musical chords played upon the piano. Each chord of the series will be played as a unit for judgment. You are expected to judge as to whether each chord played is either major or minor. If the chord played is a major chord, then record a plus symbol (+) on the proper space of your paper: if the chord played is a minor chord, then record a minus symbol (−). Each chord will be played but once. Since the numbers on your paper are arranged in serial order from one to fifty, this means that fifty chords will be played and that you in turn will make a total of fifty judgments. If you are in doubt as to whether a particular chord is either major or minor, then guess. Do not omit any judgments. After a judgment has been recorded, do not change it.

Not all of the subjects took the test. Those subjects were dismissed who never heard the terms major and minor as used in music, or who had heard the terms at some time but had no idea whatsoever as to their meaning or significance. Subjects were

given the test who understood the meaning of the terms or who had a vague notion what the terms might signify. At the close of the test, each subject was asked to answer in writing, the following questions:

1. What do you understand by the terms "major" and "minor" as used in music?

2. What is the difference between a major chord and a minor chord?

Of the total number of subjects who took the test, subjects 4 and 29, both the most thoroughly trained of the group, are the
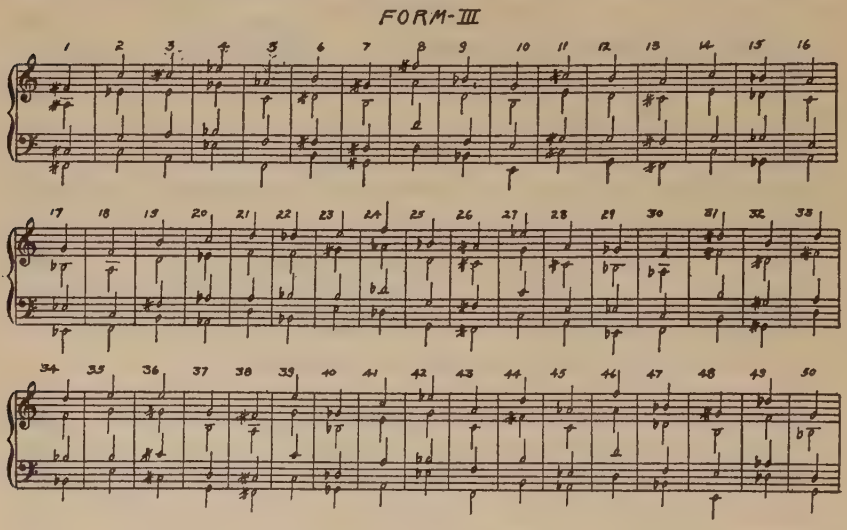
FIG. 3

only subjects who in their answers evidenced a knowledge of the technical basis and use of the terms major and minor. The answers of the remaining subjects evidenced the use of various types of criteria in distinguishing the terms from each other. Most of the responses proposed differences in feeling-tone. In most of the instances in which feeling-tone was indicated, the historically affirmed joyful-melancholy dimension seemed to be recognized as related to the two modes. The subjects' scores are given in table 2, column D. Five of the trained subjects received a score of less than 80, while eight of the untrained subjects received a

score less than 80. A score of less than 80 per cent correct is not considered, in this type of test, as having much positive significance.

TABLE 3

Individual scores in chordal discrimination, computed on a per cent correct basis, for subjects nos. 11 to 30 inclusive

Tests 1 and 3 are in root position: tests 2 and 4 are in the inverted position. (A) is the individual average for the two tests in root position: (B) is the individual average for the two tests in the inverted position. (An asterisk indicates a musically trained subject)

SUBJECT	TESTS					
	1	2	3	4	(A)	(B)
11*	98	100	100	96	99	98
12*	92	98	100	100	96	99
13	86	92	82	98	84	95
14*	94	100	90	100	92	100
15	74	72	74	84	74	78
16	100	100	100	100	100	100
17*	92	96	98	98	95	97
18	70	82	68	98	69	90
19	78	92	88	98	83	95
20	84	86	84	96	84	91
21*	100	100	100	98	100	99
22*	82	82	86	88	84	85
23	82	86	84	86	83	86
24	94	94	92	98	93	96
25	82	82	78	86	80	84
26*	98	98	100	98	99	98
27*	98	96	100	100	99	98
28	88	92	80	92	84	92
29*	100	100	100	100	100	100
30	98	100	100	100	99	100

Experiment IV

The first ten subjects were dismissed during test periods in which the second group of twenty subjects was given four tests in chordal discrimination, in content similar to the tests given in *Experiment I.* The method of control and of presentation was identical with that of the first experiment. Forms I, I-A, II, and II-A were the four tests given. The results of the experiment are summarized in table 3.

The results of this experiment bear similarity to the results obtained from the first experiment. In general, chords in the inverted position are more easily discriminated. In most instances, the trained subjects find the two chordal positions approximately equal in difficulty for discrimination, whereas the untrained subjects find the inverted position easier. Taking the group of 20 subjects, the average score for root position is 89.8, the average deviation being 8.37. For the same group, the average score for the inverted position is 94.0, the average deviation being 5.25. The distribution for the root position is bi-modal, the modes being 99 (4 cases) and 84 (4 cases): the median is 92.5. The mode for the inverted position is 100, the median 96.5. In tabulating the scores of the trained and untrained subjects within this group, the results for the trained are as follows: root position, average score = 96.0, A.D. = 7.48: inverted position, average score = 97.1, A.D. = 5.11. For the untrained subjects, the results are as follows: root position, average score = 84.8, A.D. = 9.09: inverted position, average score = 91.5, A.D. = 5.36.

The individual averages of the first two tests in simple chordal discrimination (forms 1 and 2) for the entire group of 30 subjects were correlated with the scores obtained in the Seashore pitch discrimination test. The third and fourth tests in chordal discrimination for the second group of 20 subjects, were not included, since they correspond to tests K and L which the first group of ten subjects had taken after a period of considerable learning: hence the results in the two groups, were such inclusion to be made, would demand special interpretation, and such interpretation would, for the most part, rest upon mere inference.

In table 2, columns 1 and 2 give the individual scores for forms 1 and 2 respectively. Column A gives each individual average for the two tests in chordal discrimination. Column B gives the individual scores attained in the Seashore pitch discrimination test. The scores in column A were correlated with the scores in column B. This correlation was attempted on the basis that the two functions possess elements in common. Chordal discrimination of the type heretofore outlined may be regarded as

"masked pitch discrimination," in view of the fact that a semitone pitch difference in the clang is not an isolated pitch difference, but is affected by the tonal environment which surrounds it. Employing Pearson's formula, r was found to be 0.10 plus, with a probable error of 0.12. The average deviation for function X (chordal discrimination) is 6.6: sigma = 7.6, P.E. = 5.12. The average deviation for function Y (pitch discrimination) is 10.4: sigma Y = 11.9, P.E. = 8.02. These figures lead to the conclusion that there is practically no significant correlation between chordal discrimination involving mono-semitone modification and pitch discrimination.

Experiment V

This experiment represents the main portion of the investigation to which the other preliminary experiments are directly related. In the following experiment, the first ten subjects who were temporarily dismissed were reenlisted with the second group of twenty subjects.

The experiment, as already explained in an inital portion of the text, was designed for the purpose of ascertaining the extent to which the joyful-melancholy dimension of feeling functions in trained and untrained subjects' verbal feeling responses to major and minor chords when presented under the same and different intensity conditions. The stimulus material was carefully designed and presented under mechanically controlled conditions. A Duo-Art reproducing action incorporated in a Weber upright piano served as the mechanism of control. The mechanical piano was employed for the following reasons: first, it enables presentation of variations in constant tonal intensity; and secondly, it affords practically constant tonal duration. The bellows of the piano are connected with an electric motor which maintains a practically constant speed. The piano was kept in good condition by the frequent inspection of Aeolian mechanicians, and was well tuned in equal temperament to international pitch.

The basic test form (form IV, fig. 4) consisted of 48 chords in tonic position. (This test form was made up into a special piano roll prepared and recorded by Robert Armbruster of the Aeolian

Company of New York City.) These chords include all keys in both modes, and are arranged in middle pitch register. Eight tests were given on eight different periods. These successive tests involved four different intensity schemes, each scheme being repeated once. Repetition of test form was provided for the purpose of ascertaining constancy in report to given tonal stimuli presented on different days. Since there are but twelve keys for each mode, each chord in each test was repeated for the purpose of ascertaining the extent of constancy in report to a given stimu-

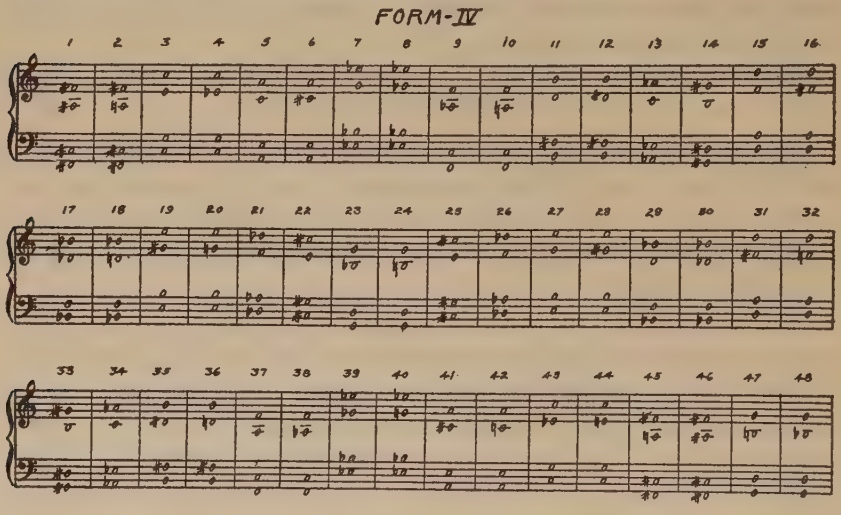

Fig. 4

lus in the same test on the same day. The tonic position was used throughout, with frequent tritone skips in the root between successive chords, in order to reduce harmonic and melodic associations. Although the chordal content of each test was the same, the intensity factor was varied for different tests. Thus in tests 1 and 5, all chords were played at piano intensity; in tests 2 and 6, all chords were played at forte intensity; in tests 3 and 7, the major chords were played forte, the minor chords piano; in tests 4 and 8, the intensity relations of tests 3 and 7 were reversed. The sequence for odd and even chords was major-minor or minor-major of a given key tone. This type of sequence was employed

to check up the frequency of duplicate responses to successive chords employing the same pitch end-points. Following the use of this type of sequence, and since from the results of the preliminary experiment in chordal discrimination it had been found that melodic inflection in the soprano position was more easily discerned than in the middle position, root chords involving alto or middle tone modification were employed. Paired-comparison method was avoided because of the associative tendencies involved in modulatory schemes in which melodic or harmonic inflection is employed. Each chord was sustained five seconds and presented as a unit for aesthetic judgment. An interval of 15 seconds separated successive chords.

A list of feeling words was presented to each subject from which he was asked to choose terms which most adequately described the feeling-tone of the chords sounded. The list emphasized the joyful-melancholy dimension of feeling, and was merely suggestive, with the subject free to choose any other terms which seemed to him more adequate for descriptive purposes. The subjects were supplied with small paper pads on each leaflet of which they recorded a separate response. Turning face downward of each leaflet upon the completion of each response aided in eliminating tendencies toward memory of test material, as well as preventing visual association with previous responses. In order to introduce a distracting element between clangs and thereby minimize the establishment of clang relationship, the experimenter called out "ready!" about two seconds before each clang was sounded. The following instructions were given to each subject:

> You will be presented with a series of musical chords. You are expected to listen attentively to the playing of each chord and to render a judgment of feeling after the chord has been sounded. You are requested to designate the particular feeling-tone which the chord arouses in you by writing an appropriate term selected from the list of terms printed below.
>
> Read over the list of terms carefully before the test begins. If no term in the list seems adequate to you in expressing a particular feeling-

tone which some chord may happen to arouse, then use a term of your own choice.

*Bright	*Joyful
*Cheerful	Melancholy
*Clear	Mournful
Dark	Plaintive
Doleful	Sad
Dull	*Soothing
Gloomy	Yearning
*Happy	

Before any of the data were analyzed, it was feared that the complexity of the subjects' responses would defy any simple statistical treatment. However, after some analysis, it was surprising to learn the extent to which the list of terms presented had been found adequate by the subjects. At the close of the experiment, the subjects were asked whether the terms listed in the direction sheet had seemed sufficiently adequate for descriptive purposes. All of the subjects agreed to the adequacy of the list. The replies of subjects 4 and 29, both trained, were especially interesting. These subjects stated that they could have classified the chords of the entire experiment by the terms *bright* and *dull*.

The list of words in the direction sheet has been divided into major and minor terms. A major term is one which has been used by investigators and musicians in the past to describe the feeling engendered by major chords. A minor term is one which has been employed in the past to describe the feeling aroused by a minor chord. Following this use, subjects' responses are said to be either major or minor responses; that is, a major term is the same as a major response, a minor term is the same as a minor response. Thus a subject may give major responses to either major or minor chords, or minor responses to either major or minor chords.[2] Many of the subjects found recourse to other terms than those listed in the direction sheet in order to describe their feeling, or in order to describe how the chords sounded to them. If these responses showed synonymous relation to the

[2] Those words in the direction sheet which are marked by asterisks are major terms; all other terms are minor.

responses listed in the direction sheet, or if they have been used by other investigators to designate the characteristics of the two modes, they were credited accordingly.

In analyzing the data obtained, it was found that in the case of 25 of the 30 subjects, the percentage of minor responses made to major chords is greater than that of major responses to minor chords. With the exception of one subject, in the other four

TABLE 4

Individual percentages of major responses to minor chords and minor responses to major chords without regard to any intensity changes

Column A indicates for each subject the per cent of minor responses which he made to major chords: in column B, the per cent of major responses to minor chords for each subject is given. (An asterisk indicates a musically trained subject.)

SUBJECT	A	B	SUBJECT	A	B
1	56.6	27.2	16	29.1	3.6
2	72.3	23.4	17*	30.2	6.7
3*	36.1	7.8	18	72.9	28.6
4*	2.6	0.5	19	58.6	20.3
5*	68.7	15.1	20	53.1	41.6
6*	57.8	23.4	21*	0	1.0
7*	58.6	31.2	22*	66.8	12.2
8*	27.7	13.7	23	21.8	22.9
9	55.2	40.6	24	26.5	29.1
10	66.6	30.7	25	34.8	18.2
11*	51.6	22.9	26*	37.5	10.5
12*	44.7	20.1	27*	15.1	3.1
13	68.2	20.8	28	25.5	34.2
14*	36.8	4.1	29*	2.0	0
15	29.3	54.1	30	1.0	1.0

remaining cases, the difference in per cent between the two types is practically negligible. For the musically trained subjects, the average per cent of minor responses to major chords is 35.7, the average deviation being 15.9. For the untrained subjects, the average per cent of minor responses to major chords is 44.8, with an average deviation of 19.4. In the case of major responses to minor chords, for the musically trained subjects the average per cent is 11.5, the average deviation being 7.7. For the untrained

subjects, the average per cent of major responses to minor chords is 26.4, with an average deviation of 9.9. (See table 4.)

It is singular to note that the subjects who scored highest in the test on major-minor discrimination are the very subjects who respond in historic conformity with the joyful-melancholy dimension of feeling. The question arises: do these subjects actually feel these chords as being joyful or melancholy, or do they merely employ major-minor discrimination as a basis for attributing feeling-tone to these chords? In other words, have the terms *sad*, *gloomy*, *melancholy*, and the like merely become exchange expressions for a purely intellectual discrimination? A clear cut answer to these questions is forthcoming.

The data also point out conclusively, excepting those subjects who scored perfect on the major-minor discrimination test and also "correctly" in this experiment ("correctly" here means that the responses were made in conformity with the historic feeling division of the major and minor modes into feeling categories of joy and melancholy) that subjects tend to respond differently to the same chord involving the same intensity in the very same test and in different tests on different days involving both the same intensities and different intensities. Changes in intensity have a marked effect in modifying feeling-tone. Two types of intensity changes may be specified; namely, relative and absolute. In absolute intensity, all of the chords of a single test are of the same intensity; in relative intensity, major and minor chords, of a given test, vary in their intensities.

The predominance of the response *soothing* in the case of soft chords is amazing. In tests 1 and 5, in which both major and minor chords are played piano, of the 837 major responses made to major chords, 146 include the response soothing, or 17.4 per cent; in the same tests, of the 210 major responses made to minor chords, the response soothing occurs 34 times, or 16.1 per cent. In tests 2 and 6, in which all the chords are played forte, of the 821 major responses to major chords, the response soothing occurs 71 times, or 8.6 per cent; in the same tests, of 210 major responses made to minor chords, 7 include the response soothing, or 3.3 per cent. In tests 3 and 7, in which all the major chords are played

forte, and all the minor chords piano, of the 982 major responses made to major chords, the response soothing occurs 26 times, or 2.6 per cent; in the same tests, of the 308 major responses made to minor chords, 240 of these are the response soothing, or 77.9 per cent. In tests 4 and 8 in which all the major chords are played piano and all the minor chords are played forte, of the 763 major responses to major chords, 376 are the response soothing, or 49.2 per cent; in the same tests, of the 360 major responses to minor chords, only 3 are the response soothing, or 0.8 per cent. The contention that the minor chord is not soothing does not agree with these results. It is found that intensity changes can and do affect the complexion of a harmonic configuration, and that a change in intensity is capable of almost completely masking the historically affirmed effect provided by either mode. It is, after all, not so much a question of what a chord is by nature of its tonal structure, as it is a question of how it is presented. A loud chord is *rarely* soothing; a soft chord is *frequently* soothing. But to state that a minor chord is *not* soothing, is certainly not justified, for the greatest number of soothing responses was obtained from minor chords when played softly. Likewise a major chord is soothing when it is played softly. But the contention that the major chord is *always* soothing is not borne out. Either loud major or loud minor chords are seldom reacted to as soothing.

In further analyzing the responses given to major chords, 13 subjects gave a greater number of major responses to loud major chords in tests 2 and 6 than they gave to soft major chords in tests 1 and 5. Thirteen subjects responded in the reverse, while 4 subjects gave the same number in each case. Twenty subjects gave a greater number of major responses to loud major chords in tests 3 and 7 than they gave to soft major chords in tests 4 and 8. Eight subjects responded in the reverse fashion, while 2 subjects gave the same number in each case.

In terms of minor responses to major chords, 12 subjects gave a greater number of minor responses to soft major chords in tests 1 and 5 than they gave to loud major chords in tests 2 and 6. Thirteen subjects responded in the reverse, while 5 subjects gave the same number of responses in each case. Nineteen subjects

gave a greater number of minor responses to soft major chords in tests 4 and 8 than they gave to loud major chords in tests 3 and 7. Eight subjects responded in the reverse fashion, while 3 subjects gave the same number of responses in each case.

In an analysis of the responses given to minor chords, it is found that 12 subjects gave a greater number of minor responses to soft minor chords in tests 1 and 5 than they gave to loud minor chords in tests 2 and 6. In the same tests, 11 subjects responded in the reverse fashion, while 7 subjects responded with the same number in both instances. Thirteen subjects gave a greater number of minor responses to soft minor chords in tests 3 and 7 than they gave to loud minor chords in tests 4 and 8. Sixteen subjects responded in the reverse fashion, with one subject responding with the same number in each case. Ten subjects gave a greater number of major responses to loud minor chords in tests 2 and 6 than they gave to soft minor chords in tests 1 and 5. Twelve subjects responded in the reverse fashion, while 8 subjects responded the same in both cases. Fifteen subjects gave a greater number of major responses to soft minor chords in tests 3 and 7 than they gave to loud minor chords in tests 4 and 8. Fourteen subjects responded in the reverse fashion, with one subject responding the same in both instances. These facts are brought out in a study of tables 5 and 6. It must be remembered that in tabulating the major responses, a large proportion of these responses to soft chords, as previously indicated, is expressed by the response "soothing."

In further statistical treatment, it is found that 11 subjects gave a greater number of minor responses than major responses to soft major chords in tests 1 and 5. Seven of these subjects are untrained. Nineteen subjects gave more major responses than minor responses to the same chords in these same tests. Eighteen subjects gave a greater number of major responses than minor responses to loud major chords in tests 2 and 6. One subject gave the same number of major responses as minor responses, while 11 subjects gave a greater number of minor responses than major responses. Eight of the first eighteen subjects are untrained, the one subject who made the same number of responses

is trained, while in the remaining group of 11 subjects, 7 are untrained. To loud major chords in tests 3 and 7, 24 subjects, 11

TABLE 5

Per cent of minor responses to major chords under different intensity conditions

(An asterisk indicates a musically trained subject.)

SUBJECT	TESTS 1–5	TESTS 2–6	TESTS 3–7	TESTS 4–8
1	75.0	72.9	44.4	33.3
2	79.1	79.1	45.8	85.4
3*	42.5	47.8	40.4	14.5
4*	0	4.1	0	6.2
5*	75.0	58.3	58.3	83.3
6*	64.5	50.0	37.5	79.1
7*	52.0	55.5	50.0	77.0
8*	18.7	31.2	25.5	35.4
9	79.1	47.9	20.8	72.9
10	79.1	68.7	43.7	75.0
11*	27.0	66.6	47.9	64.5
12*	37.5	45.6	18.7	77.0
13	72.9	58.3	70.8	72.3
14*	47.8	33.3	12.5	54.1
15	34.8	27.9	0	47.9
16	25.0	31.2	35.4	25.0
17*	25.0	20.8	52.0	22.9
18	70.8	79.1	72.9	68.7
19	65.9	75.0	41.6	52.0
20	47.9	50.0	25.0	68.7
21*	0	0	0	0
22*	68.7	82.6	62.5	54.1
23	14.5	10.4	10.4	52.0
24	31.2	33.3	39.5	2.0
25	33.3	27.0	31.2	47.9
26*	40.4	34.8	12.5	62.5
27*	10.4	10.4	10.4	29.1
28	24.4	27.0	4.2	45.8
29*	0	0	8.3	0
30	0	0	0	0
Average for trained.....	33.9	36.0	29.1	43.9
Average deviation.....	14.2	20.5	19.2	26.6
Average for untrained....	48.8	45.8	32.3	49.9
Average deviation.....	23.9	21.8	18.0	19.6

trained and 13 untrained, gave a greater number of major responses than minor reponses; one subject, trained, gave the

same number of either type, while 5 subjects, 3 trained and 2 untrained gave a greater number of minor responses than major

TABLE 6

Per cent of major responses to minor chords under different intensity conditions

(An asterisk indicates a musically trained subject.)

SUBJECT	TESTS 1–5	TESTS 2–6	TESTS 3–7	TESTS 4–8
1	25.0	10.6	60.4	16.6
2	18.7	14.5	16.6	43.7
3*	2.0	2.0	25.0	2.0
4*	0	0	0	2.0
5*	16.6	8.6	10.4	25.0
6*	10.4	27.0	22.9	33.3
7*	27.0	27.0	22.9	47.9
8*	4.1	14.6	27.0	8.6
9	31.2	37.5	31.2	62.5
10	18.7	33.3	27.0	43.7
11*	33.3	10.4	31.2	16.6
12*	12.5	13.0	10.4	44.6
13	16.6	20.8	29.1	16.6
14*	12.5	0	4.1	0
15	40.0	68.8	25.0	86.0
16	0	0	14.5	0
17*	8.3	4.1	12.5	2.0
18	31.2	14.5	43.7	25.0
19	12.7	8.3	27.0	33.3
20	37.5	39.5	31.2	58.3
21*	2.0	0	2.0	0
22*	14.5	11.3	12.5	10.4
23	12.5	8.3	20.8	50.0
24	20.8	22.9	43.7	29.1
25	14.5	10.4	31.2	16.6
26*	2.0	8.6	4.1	27.6
27*	2.0	2.0	8.3	0
28	12.7	25.0	41.6	57.4
29*	0	0	0	0
30	0	0	4.1	0
Average for trained.....	9.8	8.5	12.8	14.6
Average deviation.....	7.7	6.9	8.5	14.2
Average for untrained....	19.4	20.9	29.8	35.9
Average deviation.....	9.1	13.4	9.9	20.0

responses. To soft major chords in tests 4 and 8, 16 subjects, 9 trained and 7 untrained, gave a greater number of minor re-

sponses than major responses, while 14 subjects, 6 untrained and 8 trained, gave a greater number of major responses than minor responses.

In turning to the minor chords, it is found that in tests 1 and 5, to soft minor chords every subject gave more minor responses than major responses, but that only 4 subjects gave no major responses at all. To loud minor chords in tests 2 and 6, only 1 subject, untrained, gave more major responses than minor responses. All the rest responded in the reverse fashion; however, only 6 subjects gave no major responses at all. To soft minor chords in tests 3 and 7, only one subject, untrained, gave a greater number of major responses than minor responses. All the rest responded in the reverse fashion; however, only 2 subjects gave no major responses at all. It is found that the subjects who did not give any major responses are those who scored highest in the test on major-minor discrimination. To loud minor chords in tests 4 and 8, one untrained subject gave an equal number of major and minor responses, 4 untrained subjects gave a greater number of major responses than minor responses, while 25 gave a greater number of minor responses than major responses.

In a study of duplicate responses to successive different chords of the same key-tone, it was found that in general untrained subjects made more duplicate responses than trained subjects and that those subjects who scored low in chordal discrimination made the largest number of duplicate responses, whereas those who scored highest in chordal discrimination made the least duplicate responses. It is interesting to note that the greatest number of duplicate responses occurred in tests 1 and 5, and in 2 and 6, in which the intensity factor was not varied. The fewest number of duplicate responses occurred in tests 4 and 8. This tends to indicate for discrimination the greater dynamic possibilities in function of relative intensity over absolute intensity.

Besides changes in intensity modifying response, changes in pitch were also found responsible for different types of response. In analyzing the nature of responses to both the major and the minor chords of the pitch extremes involved in the test, it was

found that to chords 10 and 37 (F-major), 16 subjects, 5 trained and 11 untrained, gave a greater number of minor responses than major responses, 1 untrained subject gave an equal number of major and minor responses, while 13 subjects, 10 trained and 3 untrained, gave a greater number of major responses than minor responses. To chords 19 and 28 (E-major), 26 subjects, 14 trained and 12 untrained, gave a greater number of major responses than minor responses, 2 untrained subjects gave an equal number of major and minor responses, while 2 subjects, one trained and the other untrained, gave a greater number of minor responses than major responses. To chords 9 and 38 (F-minor) every subject gave a greater number of minor responses than major responses. To chords 20 and 27 (E-minor) 8 subjects, 2 trained and 6 untrained, gave a greater number of major responses than minor responses, 2 untrained subjects gave an equal number of major and minor responses, while 20 subjects, 13 trained and 7 untrained, gave a greater number of minor responses than major responses. Twenty-two subjects, 13 untrained and 9 trained, gave a greater number of major responses to the E-minor chord in upper register than to the F-minor chord in low register. Twenty-two subjects, 13 untrained and 9 trained, gave a greater number of major responses to the E-major chord in upper register than to the F-major chord in low register.

Thus it can be seen that for either a major or a minor chord, the chords in the upper pitches call forth a greater percentage of major responses relative to the chords in the lower pitch region. These results are in keeping with the subjects' introspective reports on this point.

At the close of the experiment, the following list of questions was answered by each subject in writing:

1. What criteria have you employed as means for determining the feeling-tone attached to any chord?
2. (a) How many different rolls were played?
(b) What did the differences between the rolls consist of?
3. Did you find any two successive chords alike in tonal structure in any of the rolls?
4. How many such chordal repetitions did you notice in each roll?

5. (a) Were there any rolls repeated?

(b) If so, which rolls (indicate number) and what was the order of repetition?

6. (a) Were all the chords struck with the same intensity?

(b) If not, in what rolls did the intensity factor vary for different chords?

7. What effect, if any, did changes in the intensity of a chord have upon your feeling-tone judgment?

8. (a) Did changes in pitch have anything to do with your judgments?

(b) If so, in what way?

9. (a) Did you employ major-minor discrimination as a criterion for your feeling-tone judgments?

(b) To what extent?

(c) Describe your use of such a criterion.

(d) Why did you employ this type of discrimination as a basis for judgment?

The following outstanding facts present themselves from an analysis of these reports. Different subjects are found to use different criteria as bases in the determination and in the choice of feeling terms. In some instances, the chords aroused trains of associations, and were associated with and judged in relation to certain musical compositions. Nineteen subjects employed major-minor discrimination as a basis for judgment. On the basis of previous experiments and reports already reviewed, since a large number of these subjects comprehended by major-minor discrimination something entirely foreign to modal structure and differentiation, various types of criteria as bases for judgment are introduced. However, in the case of those who have understandingly employed modal differentiation, one finds that a sad chord is not a minor chord, but that a minor chord is a sad chord; in like manner, a bright chord has merely become an exchange phrase for a major chord. In orally questioning subjects 4 and 29, the two most thoroughly trained of the group, they declared at the close of the experiment that every time they decided upon a chord as being minor, they put down the term *dull* or some term related to this category; in like manner after deciding a chord was major, they wrote down the term *bright* or some other

related word. From a study of the answers given, it is found that a similar method was adopted by a number of other subjects. This fact viewed in relation to the type of results which these subjects gave is probably one of the most outstanding facts discovered in this investigation which, it is believed, aids considerably in lifting the veil of mystery which has for such a long period of time beshrouded a very simple problem.

It is found that changes in intensity have different effects upon different subjects. Changes in pitch also tend to modify judgment. Most of the subjects considered the high pitches as bright, happy, and cheerful, whereas the lower pitched chords gave feelings of gloom and melancholy. Twenty-one subjects stated that they found successive chords identical in tonal structure in some of the rolls. Failure at discrimination thus probably accounts for the large number of duplicate responses. It is also revealed that in many instances successive chords were contrasted in regard to both pitch and intensity by trained and untrained subjects as well. This points out the fact that retention images of pitch and intensity relationships function after a period of fifteen seconds despite the various distracting elements encountered during this time, such as the voice of the experimenter remarking to get ready, and the writing down of judgments. The large number of answers in the negative to questions 2, 4, and 5 convince one that memory for chords or sequences functioned very little, if any, and that there was little attempt made at identification of test material.

Experiment VI

This experiment was conducted for the purpose of ascertaining the extent to which responses to entire compositions in the two modes coincided with the historic modal attributes and with the nature of subjects' previous responses to major and minor chords. A series of seven musical compositions was presented within a single hour period. A time interval of approximately five minutes separated the presentation of successive pieces. The first two compositions were played on the Duo-Art reproducing piano; the remaining five compositions were played on the

electric phonograph. The compositions in the order of their presentation were the following:

1. The largo movement (first theme) from the Fifth Symphony in D-flat by Dvorak.
2. Anitra's Dance from the Peer Gynt Suite, by Grieg.
3. Largo from "Xerxes," by Händel, played by Sousa's Band.
4. Caprice Viennois, by Fritz Kreisler, and played by the composer.
5. Spanish Dance No. 2, by Popper, and played by Pablo Casals.
6. Intermezzo from Thais, by Massenet, played by Maud Powell.
7. In the Days Gone By, from "Countess Maritza," by Emmerich Kalman.

The subjects attended in small groups, and were comfortably seated some distance (about 20 feet) from the instruments. They were asked to listen to the compositions played as they would ordinarily listen to any musical composition. At the conclusion of each composition, the subjects were asked to choose and to write down those terms which they considered adequate in describing the emotional setting of the composition, or in describing the emotional effect which it exerted; secondly, they were asked to indicate as to whether or not they had heard the composition before; thirdly, they were asked to give the place of hearing; fourthly, the name of the composition and the composer were requested; and lastly, as to whether or not the subject had ever played the composition.

In general, composition 1 (major) was reacted to as being melancholy, sad, and plaintive. Composition 2 (minor) was reacted to almost throughout as bright, cheerful, and happy. Composition 3 (major) was in most instances reacted to as sad, melancholy, and mournful. Composition 4 (major) was reacted to in a variety of ways, both as being melancholy and as being bright and cheery. Composition 5 (major-minor) was also given a large variety of responses, although the majority of these were in minor terms. Composition 7 (minor-major) was given a majority of major responses.

Although these results conclusively demonstrate that a composition written in the major mode is not necessarily bright and

cheerful because of that fact, and that a composition is not held to be sad and melancholy despite the fact that it is written in the minor mode, undue stress must not be placed upon responses given to whole compositions. In reaction to entire compositions, it is difficult to state just what particular factors or elements a subject is reacting to. It is quite possible that a subject's response coincides with some unusual feature or contrast that forms a very small item in the total musical production. Reaction may be to timbre changes or specific tonal qualities, to changes in rhythm and tempo rate, to changes or contrasts in intensity, to harmonic figures of an unanticipated type, to melodic inflection and pitch relationships of a more general type, and to numerous other associations and considerations. Such a reaction to a single composition as that of subject 6 (composition 1), for example, (mournful, happy, joyful, cheerful, sad) shows response to a number of varying features. It is interesting to note, however, that those subjects who reacted in the greater majority of cases to major chords as bright, cheerful, happy, and so on, reversed their decision in major compositions. Likewise, there was little coincidence in responses given to minor chords and to minor compositions.

In connection with reaction to the modes as a product of training, a brief study was made to ascertain the fundamentality of the major mode in musical literature. The writer visited a local music shop and browsed through several hundred compositions written for beginners. Random sampling of the compositions of five different publishers revealed a surprising minority of minor compositions (approximately 7 per cent), especially among the elementary grades. This discovered feature led to a further study of musical catalogues. Of more than 2,500 compositions reviewed, again approximately 7 per cent were written in the minor mode. These facts lead one to believe that music, especially for beginners, written in the major key greatly predominates quantitatively over that written in the minor mode. Furthermore, it tends to throw some light on the fact that the type of composition which beginners receive in their early instruction periods is that written in the major mode. Practically all of

the beginners compositions which were reviewed had descriptive titles. It is a difficult matter to obtain a composition in the minor mode written for children that does not have a title related to the weird, the mysterious, the sad and the gloomy. Apparently, composers in their attempts to differentiate the modes for children fall victim to the method of introducing titles opposite in feeling content. To children, the title of a composition is a very outstanding feature. Thus, specific feeling-tone introduced into the title of a composition becomes easily associated with specific types of harmonic and melodic figures.

It may be, after all, that reaction to the modes is largely a question of the extent to which association with descriptive titles of a specific variety first establishes the affective impressions in the mind of the beginner. If children react to the modes in the characteristic Helmholtzian fashion, is it because their reaction is a naïve and spontaneous response to a tonal complex which is potent to arouse definite visceral patterns, or is it because their reaction has become adulterated to previously established associations which have been forced upon them? Although, in the light of the nature of much of the beginners' training, the latter view seems the more plausible explanation, the explanation itself remains a mere tentative hypothesis until further experimental investigations have been conducted on children at early ages before modal sophistication has been allowed to crystallize.

SUMMARY OF RESULTS AND CONCLUSIONS

Experiment 1. Discrimination between two chords, sequentially arranged as major-minor or minor-major, constructed in open position on the same root with mono-semi-tone modification of the soprano, either ascendingly or descendingly, is easier than that between two chords, each of a different mode, constructed in open position on the same key-tone with similar pitch alteration provided for in the alto position. In test repetition with pairs of chords presented in different sequential orders, both trained and untrained subjects show increased ability to discriminate between chords in both tonic and inverted positions. Ability to differentiate between two chords is correlate with the

nature, degree, and efficiency of musical training. Subjects most thoroughly trained find discrimination between the two chordal positions, tonic and inversion, approximately equal in difficulty. Subjects less adequately trained as well as those untrained find it easier to discriminate between two chords in the inverted position.

In general, both trained and untrained subjects err on different pairs in different tests given on different days. Certain chordal pairs are found to be more difficult for discrimination: these are located in the low and high pitch registers. For both trained and untrained subjects, chordal modification is more easily discriminated in middle register. Error in discrimination to pairs consisting of diverse tonal constituents is more probable than error in identification to pairs of the same tonal constituents.

Experiment 2. Ability to discriminate between two pitch points involving a frequency difference of less than five vibrations is not a fundamental requisite or factor in the make-up of the musically trained who have become successful performers.

Experiment 3. Only two out of thirty subjects were able to offer an adequate explanation of the technical difference between a major chord and a minor chord. Both trained and untrained subjects may attain perfect scores in major and minor discrimination without being able to specify the basic tonal differentia. Both trained and untrained subjects entertain various criteria as bases for differentiating major and minor chords. Most of the responses propose differences in feeling-tone. In many instances in which feeling-tone is indicated by both trained and untrained subjects, the historically affirmed joyful-melancholy dimension is recognized as related to the two modes.

Experiment 4. Results in further testing of chordal discrimination confirm those obtained in *Experiment 1.* Using Pearson's formula, the coefficient of correlation between pitch discrimination and chordal discrimination is $r = 0.10$, P.E., 0.12.

Experiment 5. Reaction to major and minor chords in conformity with the joyful-melancholy dimension of feeling is dependent upon training to react in this specific manner. In the case of both trained and untrained subjects who are able to dis-

criminate between chords of the two modes, specific feeling-tone words have become exchange terms for technical designations of variations in tonal structure. There is no fixity of feeling-tone intrinsic to a given chordal combination. In the case of trained subjects who give fairly constant reactions in relation to the joyful-melancholy categories of feeling, feeling judgment is largely based upon intellectual discrimination between tonal configurations. The subjects who scored highest in major-minor discrimination are the very subjects who respond in historic conformity with the joyful-melancholy dimension of feeling.

For both trained and untrained subjects, the percentage of minor responses made to major chords is greater than that of major responses to minor chords. This is true for both absolute and relative intensity changes. Intensity changes do affect the complexion of a harmonic configuration. A change in intensity is capable of almost completely masking the historically affirmed effect provided by either mode. A loud chord is rarely soothing; a soft chord is frequently soothing. This is true for both trained and untrained subjects. The greatest number of soothing responses for both trained and untrained subjects was obtained from minor chords played softly. A major chord is likewise soothing when played softly. Either loud major or loud minor chords are rarely reacted to as soothing. This is true for both trained and untrained subjects.

Loud major chords under relative intensity changes evoke major responses more frequently than soft major chords. Soft major chords under relative intensity changes evoke minor responses more frequently than loud major chords. Loud minor chords under relative intensity changes evoke major responses more frequently than soft minor chords. Intensity changes affect those subjects least who have been trained to respond in a specific manner to the two modes and who stand highest in chordal discrimination.

In the case of both trained and untrained subjects, reaction is often determined and modified through association of a particular chord with a specific musical phrase or composition together with the related features surrounding it as well as the mood which accompanies it in recollection.

To successive different chords of the same key-tone, untrained subjects give more duplicate responses than trained subjects. Those subjects who scored low in chordal discrimination made the largest number of duplicate responses, whereas those who scored highest in chordal discrimination made the least duplicate responses. The greatest number of duplicate responses occurs in those tests in which the intensity factor is absolute. The fewest number of duplicate responses occurs in those tests which involve relative intensity changes. This tends to indicate for discrimination the greater dynamic possibilities in function of relative intensity over absolute intensity.

Changes in pitch modify feeling-tone reaction to chords of either mode. Chords, either major or minor, in the upper pitch register, call forth a larger percentage of major responses than do chords in the lower pitch register. Reciprocally, chords of either mode in the lower register call forth a greater percentage of minor responses than do chords of either mode in the upper pitch register.

Auditory retention images of pitch and of intensity relationships persist and function after a period of fifteen seconds despite the various distracting elements encountered during the interim between two segregated chords.

Experiment 6. The assumptions long entertained by theorists in regard to the supposed intrinsic characters of the modes must be dismissed. It has been shown that reaction to harmonic configuration is variable for both trained and untrained subjects. The mode in which a composition is written has little relation to the type of feeling which the composition may arouse. Minor compositions may be reacted to by both trained and untrained subjects as bright, happy, cheerful, joyful, and exuberant, whereas major compositions may be reacted to as gloomy, plaintive, melancholy, and mournful. Any fixity of feeling-tone in relation to a given mode is dependent upon training to react in a specific manner to a purely intellectual discrimination. Mood fluctuations and general temperamental differences provide for variations in interpretation.

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